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Comparison of Material Properties Made by 3D-Printing Process Using Two Different Materials

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ABSTRACT

3D Printing Process: refers to processes in which material is joined or solidified under computer control to create a three-dimensional object, with material being added together. In this Study, a Prototype model is designed using solid works software and have 3d printed the prototype using two different materials like PLA (Poly-Lactic Acid) and ABS (Acrylonitrile butadiene styrene). The 3D printed prototypes are then tested by using compression testing machine to find out there mechanical properties.

Keywords: 3D Printing, PLA, ABS, Material Properties

1. INTRODUCTION

Additive manufacturing, is the process of using specialized equipment to assemble, via a computer and a 3D model, an object layer by layer. It has some unique and interesting advantages over traditional manufacturing. First**,** additive manufacturing allows production costs to stay the same rather there are one or a thousand units. This has several implications: it makes production available to small businesses that don't have access to expansive funding and don't know in advance whether they'll have many buyers; it reduces the time between conception and sale; it allows each piece to be customized and unique; it allows greater risk-taking by reducing the cost of failure. Second**,** additive manufacturing reduces lead time for short production runs and permits the creation of very complex shapes without added costs.

However, additive manufacturing is still less competitive than traditional manufacturing when it comes to mass production, perfectly smooth finish, production of very large objects and the use of certain materials [1]. Traditional manufacturing like injection molding requires mass production to even out the overhead cost of tooling, labor for assembly, and production (an injection mold can cost thousands of dollars). On the contrary, with additive manufacturing, the cost of manufacturing of one item stays the same no matter what the quantity is, making it cheaper when the quantity is small.

Fig.1 Additive Manufacturing Vs Traditional Manufacturing

The graph, based on a study by Sculpteo, shows the compared price of a car handleproduced by injection molding (Quick parts) or additive manufacturing (Sculpteo). For up to 407 units, it remains cheaper to use 3D printing [1].

2. MODELLING OF PROTOTYPE USING SOLID WORKS SOFTWARE

To find out the difference in properties of the prototype made by two different materials, a known mechanical part i.e. a gear is designed using solid works software as shown in below following figures:

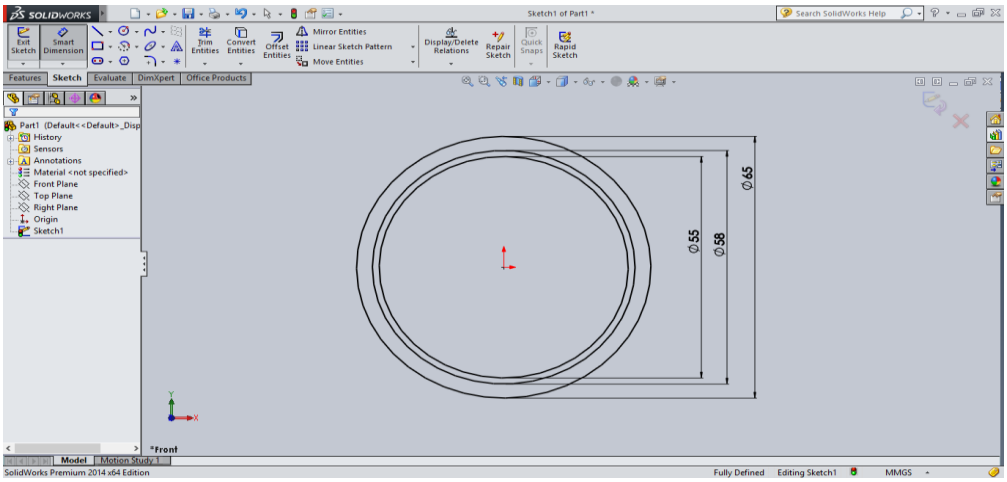

Fig.2 D1 = 65mm; D2 = 58mm; D3 = 55mm

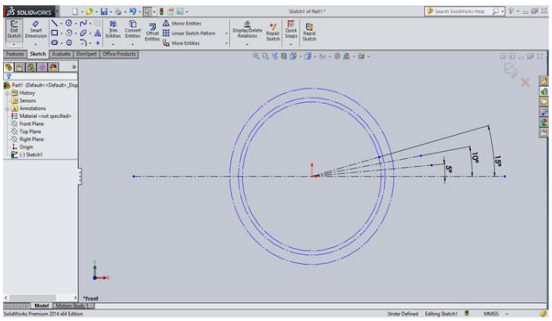

Fig: Arc 1 = 15*; Arc 2 = 10*; Arc 3 = 5*

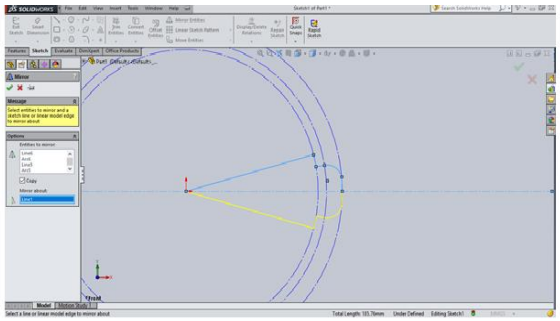

Fig: Applying Mirror effect for one half

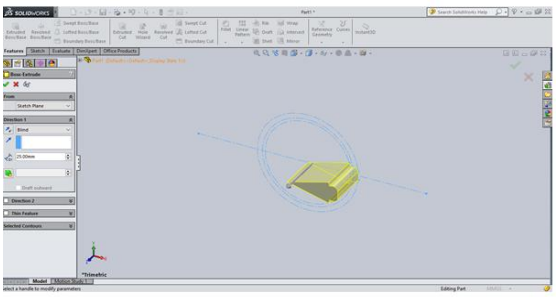

Fig: One part of teeth of the gear obtained by applying extruded base option

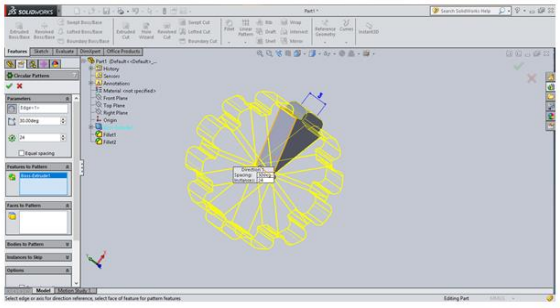

Fig: Applying Circular pattern option ion the single teeth to get full gear

Fig.3 Sequence Process of Designing of Gear

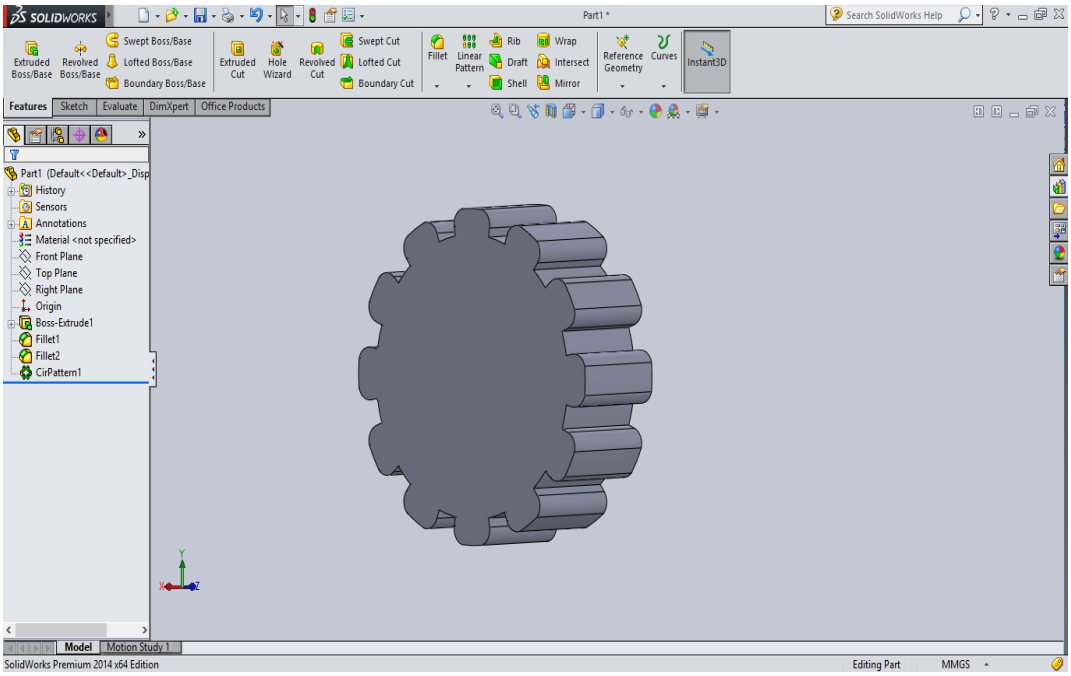

Fig.4 3D model of Designed Worm Gear

2.1 Converting and verifying STL File

Once the prototype model is designed in solid works software, it is converted to .stl file format and verified using 3D printing machine (Makerbot) software as shown in following figures.

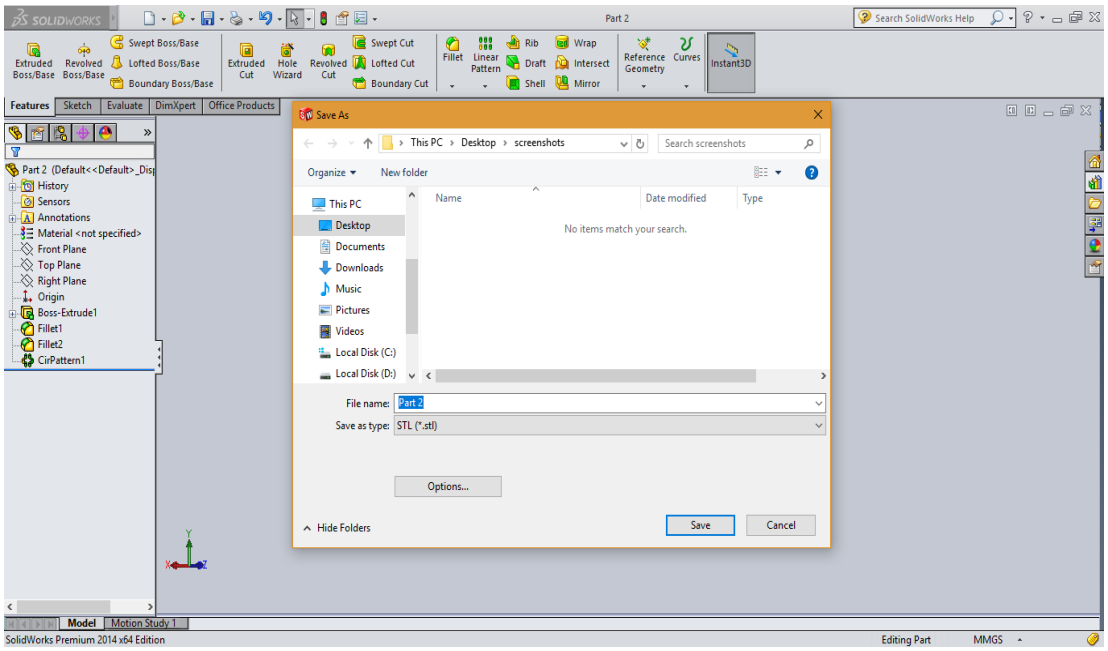

Fig.5 Converting 3D Model to Stl file

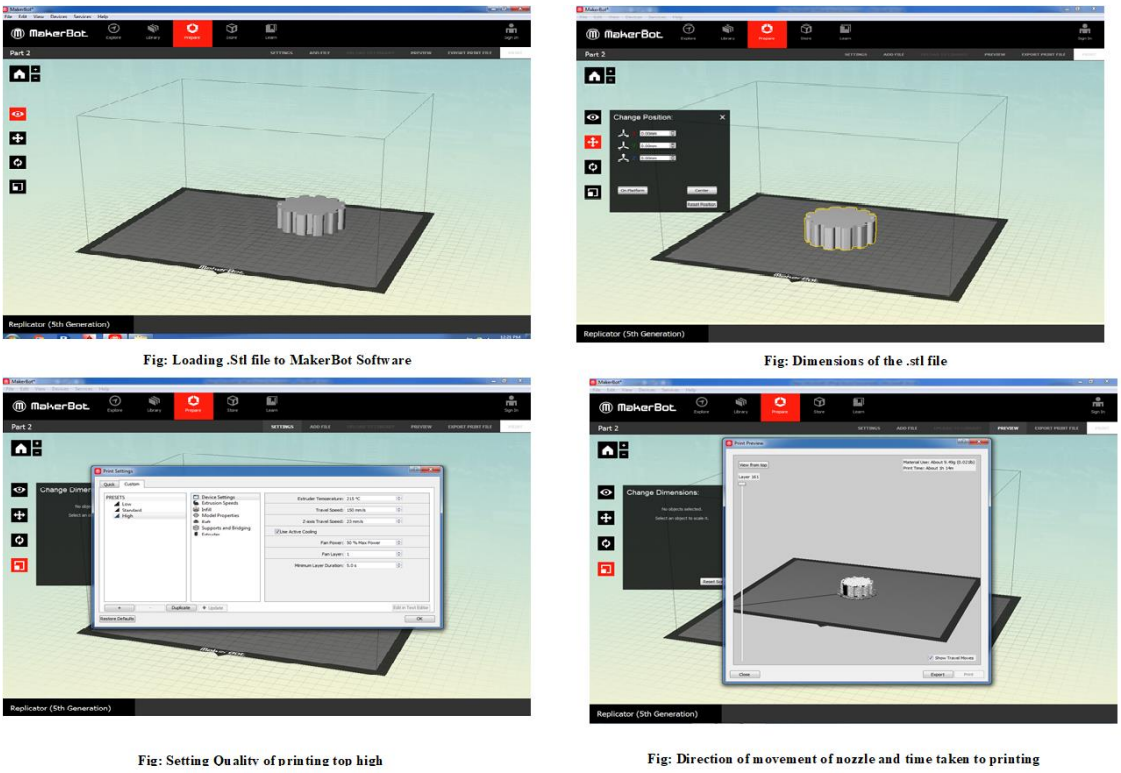

Fig: Loading .Stl file to MakerBot Software

Fig: Dimensions of the .stl file

Fig: Setting Quality of printing top high

Fig: Direction of movement of nozzle and time taken to printing

Fig.6 Verifying and Setting Properties in 3D Printing Software

2.2 3D Printing of Prototype by Two Materials

After Modelling and Verifying the properties of the prototype to be printed in machine software, it is loaded and printed by using Ultra maker 3D printing machine which is located at Think3D, Khairtabad, Hyderabad by using two materials namely PLA (Poly-Lactic Acid) and ABS (Acrylonitrile butadiene styrene) as shown in following figure 7.

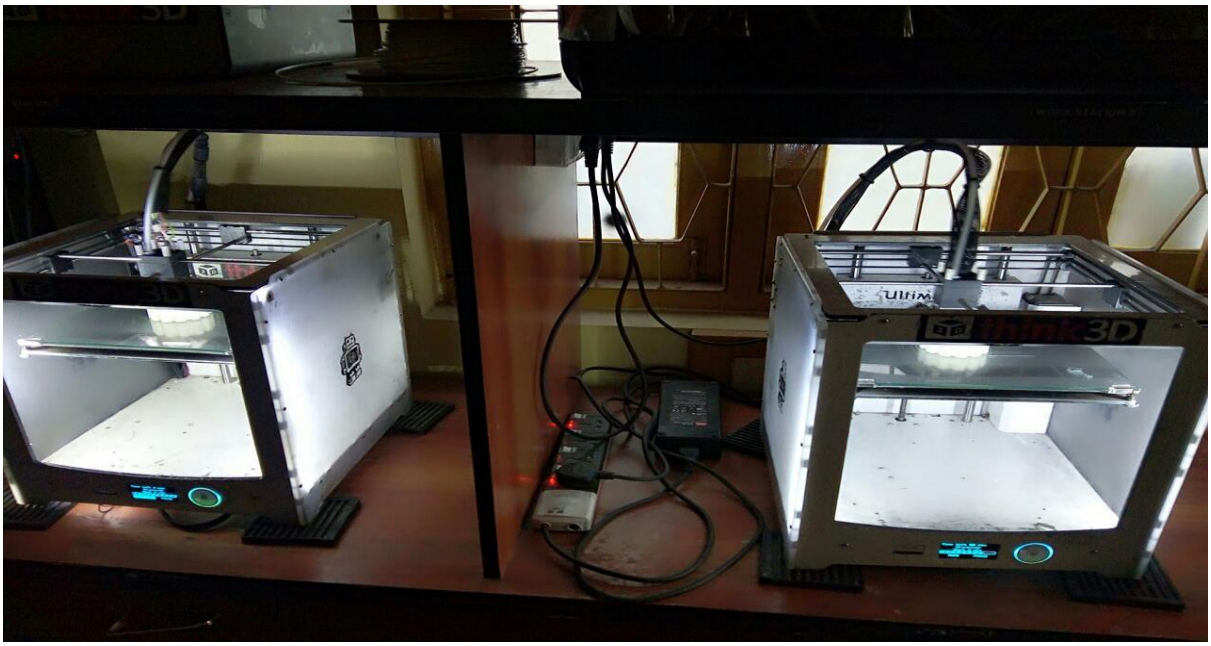

Fig. 7 printing the part with two different materials PLA and ABS

2.3 Loading of materials in UTM Machine

After the parts are printed with two different materials i.e. PLA and ABS with high quality, materials are tested with compression test by Universal Testing Machine UTE 60 located in Jyothi Spectro Analysis PVT LTD, Balanagar, Hyderabad.

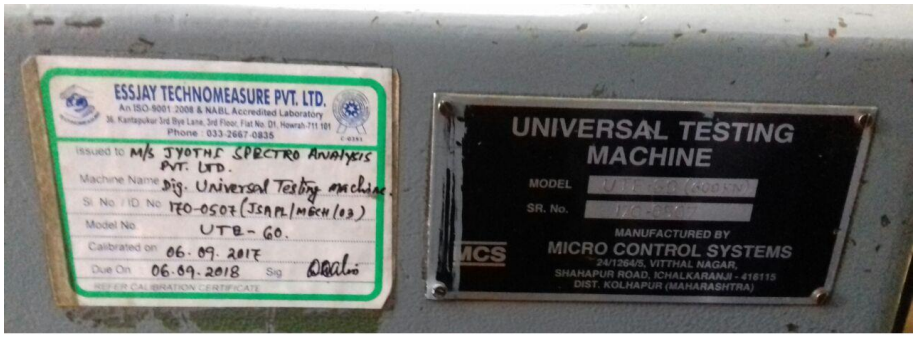

Fig.8 UTM UTE 60 Machine

Fig: Loading PLA Printed part in UTM Machine

Fig: Loading ABS Printed part in UTM Machine

Fig.9 Loading of Parts in UTM UTE 60 Machine

3. RESULTS AND DISCUSSION

The two materials i.e. PLA and ABS when loaded in UTM machine got compressed when load is applied at 32.460 and 32.280 respectively which is shown in below table as well as represented in form of graph.

Table 1 Compressive load for two different materials

S No.	Material Used	Compressive Load
1	PLA	32.460
2	ABS	32.280

Fig.10 Compressive load for two different materials

4. CONCLUSION

From the Experiment, a 3D model of a worm gear using Solid Works software which has been converted to .stl file which has been crosschecked for errors. After final verification the parts are printed with high quality using two different materials namely PLA and ABS from which the above two parts are tested using UTM machine. For the part printed using PLA material the result obtained is 32.460 at which the material has deformed. For the part printed using ABS material the result obtained is 32.280 at which the material has deformed. These materials can be used alternatively to the plastic materials which are used in manufacturing of automobile parts like scuff plates, bumper, package tray skin etc…which may have compression strength less than pla and abs materials.

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